ABSTRACT

This chapter discusses second language (L2) learning processes from cognitive perspectives gained from psychology and second language acquisition (SLA) research. A particularly useful cognitive theory for elucidating L2 learning processes from a cognitive perspective is skill acquisition theory. In L2 learning, declarative knowledge consists of exemplars and rules that L2 learners are usually aware of, while procedural knowledge is used by applying declarative knowledge to behaviors/skills, such as L2 comprehension and production. Optimal practice scheduling is a particularly burgeoning research area and is inspired by cognitive psychology research. L2 researchers have started to reveal the optimal timing to repeat L2 practice activities for proceduralization and automatization. In cognitive psychology research, distributing practice opportunities over multiple study sessions has been proven to be more valuable for long-term retention. Compared to cognitive factors like aptitude, however, relatively little attention have been given to the affective and motivational factors for research on L2 practice. Implications of many of the findings are somewhat straightforward.

Chapter 1

The Cognitive Approach

YUICHI SUZUKI

Introduction

In this chapter, second language (L2) learning processes are elucidated from cognitive perspectives gained from psychology and second language acquisition (SLA) research. While L2 acquisition involves complex cognitive mechanisms, these are naturally embedded in social contexts, and the importance of social, affective, and conative factors and their interaction is widely recognized. Yet, the internal or cognitive mechanisms and processes presumably share some key commonalities across all L2 learners with different affective and motivational levels in various social contexts. Thus, it is worth investigating and seeking to understand the cognitive underpinnings of L2 learning.

Historically, theories of L2 learning have drawn upon cognitive approaches. For instance, in their edited book, *Theories in second language acquisition: An introduction*, Vanpatten and Williams (2015) presented ten "mainstream" L2 theories, eight of which were cognitive (e.g., usage-based approaches, skill acquisition theory, input-processing model, declarative-procedural model, processability theory). These eight theories are not exhaustive even within cognitive approaches. Over a decade ago, Long (2007) pointed out that there are "as many as 60 theories, models, hypotheses, and theoretical frameworks" (p. 4). As such, an extensive list cannot be addressed within a single chapter, here, focus will be placed on skill acquisition theory, as this cognitive theory is deeply rooted in psychology literature and highly relevant for language learning.

In what follows, the foundational concepts of memory and knowledge in cognitive psychology are briefly outlined. Next, skill acquisition theory is delineated from SLA perspectives and several key issues are highlighted. Last, an integrated perspective of SLA and cognitive psychology—the main theme of this chapter—is presented.

Cognitive Perspectives in Psychology

Many essential constructs in SLA stem from cognitive psychology, which is the scientific study of human mental processes, such as perception, attention, consciousness,

memory, automatization, and language. Two related constructs—memory and knowledge—are posited to play critical roles in learning. Psychologists have a particular interest in *memory*, i.e., the underlying mechanisms that support diverse forms of learning. While memory was once considered a unitary system, it is now generally believed to be multi-componential (Baddeley, Eysenck, & Anderson, 2014). Declarative and nondeclarative memory (e.g., Squire & Zola, 1996), as well as working memory (Baddeley, 2012), are the most influential conceptualizations of human long-term memory not only for psychologists but also for L2 researchers. Declarative memory is used for learning of factual information and events, whereas the nondeclarative type of memory is involved in procedural, priming, conditioning, and non-associative learning. A well-known concept, working memory, is responsible for temporarily storing and manipulating information for carrying out complex cognitive tasks. From a cognitive perspective, these memory systems form the foundation for acquiring *knowledge* that is dedicated to specific processes by experiencing and encoding events from the environment (e.g., Anderson, 1996). For instance, L2 learners need to process and analyze L2 input such that they develop mental representations—L2 knowledge—that can be used for communication.

A number of empirical studies in the field of cognitive psychology and education have also provided valuable insights into the effectiveness of various teaching techniques in promoting learning in general (e.g., feedback, distributed learning, and individualized instruction). In the effort to promote 'science of learning', Hattie and Yates (2013) synthesized the meta-analyses of cognitive psychology findings regarding effective teaching and learning strategies that can be utilized in research-informed classroom teaching (see also Horvath, Lodge, & Hattie, 2016).

Although psychology research has generated a number of insights that could be applied in education, in most cases, researchers tended to examine simple tasks (Wulf & Shea, 2002) that are only remotely related to L2 learning. Consequently, the findings pertaining to the effectiveness of certain techniques in psychology may not always be applicable to L2 learning. While some cognitive psychologists are interested in L2 learning, the scope of L2 learning examined in such studies is often limited. In the past, for instance, L2 learning was equated simply with vocabulary acquisition (e.g., Donovan & Radosevich, 1999). Historically, psychologists rarely delved into the complexity of L2 learning; however, this situation changed dramatically in the past decade. Recently, L2 researchers have started incorporating and testing findings reported by psychologists (Suzuki, Nakata, & Dekeyser, 2019b), and this emerging field will be discussed in depth in the "Integrating perspectives" section.

Cognitive Perspectives in SLA

Skill Acquisition Theory

A particularly useful cognitive theory for elucidating L2 learning processes from a cognitive perspective is skill acquisition theory (Dekeyser, 2015). It stems from Anderson's adaptive control of thought-rational (ACT-R) theory in psychology (Anderson et al., 2004). In an overview of the field of psychology and SLA, Dörnyei (2009, 2019) identified this theory as one of the most useful frameworks that offers a concrete approach to studying L2 learning from a psychology perspective.

According to skill acquisition theory, knowledge has declarative and procedural forms. In L2 learning, declarative knowledge consists of exemplars and rules that L2 learners are usually aware of, while procedural knowledge is used by applying declarative knowledge to behaviors/skills, such as L2 comprehension and production. For instance, when learners possess declarative knowledge of third person *s*, they can explain when the morpheme -*s* is used at the end of the verb. Using this declarative rule as a crutch, they practice producing or comprehending sentences by paying attention to the target morpheme -*s* that is embedded in its surrounding linguistic information. Engaging in this type of deliberate practice leads to proceduralization. Further fine-tuning of linguistic knowledge requires substantial practice, and this gradual process is described as automatization. Automatization leads to faster, more consistent and efficient utilization of acquired skills. In sum, the theory presupposes three stages of L2 learning: declarative−procedural−automatization.

The key long-term memory systems—declarative and procedural memory—are also highlighted in Michael Ullman's declarative-procedural model (Ullman, 2015, 2016). According to this neurobiological L2 learning model, learners gradually shift from the declarative to the procedural stage as their L2 proficiency increases. Unlike skill acquisition theory, the declarative-procedural model does not seem to distinguish between the procedural and automatization phases. What is important for L2 researchers and teachers, however, is that both theories can provide a theoretical neuro-cognitive foundation for the way L2 learners develop their knowledge and skills.

This dual-memory system view of L2 knowledge can easily be linked to explicit and implicit knowledge, which are key constructs in both SLA and psychology. Declarative and procedural knowledge correspond to explicit and implicit knowledge in most cases; however, some discrepancies in operational definitions utilized by L2 researchers do exist, which has led to long-lasting controversies fueled by confusion. The distinction between explicit and implicit knowledge is based on the criterion of

awareness. Explicit knowledge is conscious, whereas implicit knowledge is used without awareness (Dekeyser, 2003; Williams & Paciorek, 2015). In contrast, declarative and procedural knowledge are often distinguished, irrespective of awareness, by the neurobiological long-term memory systems involved: declarative memory (hippocampus and medial temporal lobe) and procedural memory (frontal-basal ganglia circuits), respectively (Paradis, 2009; Ullman, 2015, 2016).

From a pedagogical perspective, the declarative-procedural-automatization distinction, rather than the explicit-implicit distinction, fulfills the purposes and is perhaps more useful in analyzing cognitive underpinnings of L2 learning processes in most classroom contexts. This is because highly advanced L2 learners can develop conscious, explicit knowledge and are able to access it quickly (Suzuki & DeKeyser, 2015; Suzuki, 2017). In other words, these advanced L2 learners can use speeded-up or automatized explicit knowledge that is presumably useful for communication, and the acquisition of unconscious, implicit knowledge, unless it is highly automatized, may be of less concern for practitioners at least. Automatization of implicit knowledge necessitates extensive L2 exposure and may take a number of years to develop typically beyond classroom contexts, and only some portion of L2 grammatical knowledge may ultimately become implicit in the sense of non-awareness even in naturalistic settings (Paradis, 2009; Suzuki & Dekeyser, 2017c).

Rather than the idea of "implicit" learning without awareness, proceduralization may be a construct that is more applicable to analyzing L2 learning process and perhaps achieved realistically in classroom settings. According to skill acquisition theory, initial proceduralization can be achieved after just a few attempts in some cases (DeKeyser, 2015). Automatization emerges from this procedural knowledge and skills and requires a long learning process, which is a useful conceptualization for tracking the L2 learning progress from a longitudinal perspective. The discussions presented in this chapter primarily focus on the transition from the declarative to the procedural learning phase, and finally to automatization, irrespective of awareness, as this learning mode is likely to be most relevant in the majority of L2 learning classroom settings.

Key Issues and Research from the Skill Acquisition Perspective

The chief objective of research guided by skill acquisition theory is elucidating how declarative−explicit knowledge, which is initially acquired deductively or inductively, supports proceduralization and automatization. In the seminal study conducted by Dekeyser (1997), participants were exposed to artificial grammar rules during the course of 22 sessions delivered across 11 weeks. After participants acquired

declarative (metalinguistic) knowledge about target rules, they engaged in systematic comprehension or production practice involving 1,440 sentences. Analysis of their performance showed that accuracy and speed gradually improved with the number of practice opportunities, as indicated by the Power of Law learning curve (Figure 1).
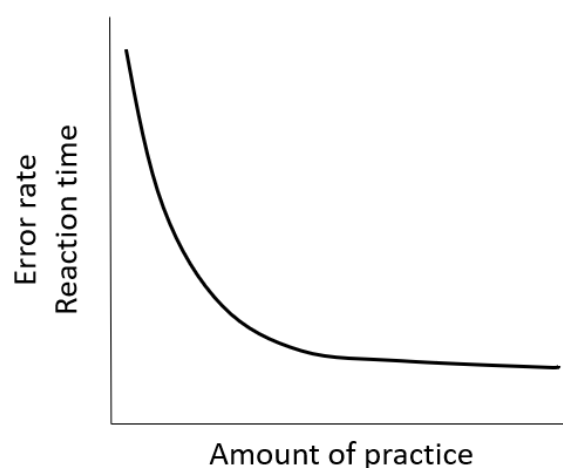
Figure 1. Power of Law Curve.
Note: Error rate and reaction time decreases dramatically in the initial study sessions and the decline becomes asymptotical over time.

While many empirical studies rooted in skill acquisition theory are conducted in controlled laboratory settings, Sato and McDonough (2019) carried out their investigation in an English-as-a-foreign-language (EFL) classroom. They examined the role of declarative knowledge in proceduralization of wh-questions through contextualized speaking practice. The participants (EFL learners) engaged in a variety of teacher−student information−gap tasks (e.g., spot-the-difference task, interview task, story completion), with the aim of acquiring procedural knowledge of wh-questions, over five weekly sessions. The authors found that accuracy, speech rate, and mean pause length significantly improved over the five sessions, confirming that the 'practice effects' previously observed in the lab can be extended to contextualized practice in the classroom. Although declarative knowledge was not a significant predictor of performance change from the first to the final (fifth) session, declarative knowledge allowed the learners to engage in using the target structure accurately in the initial stages of proceduralization. This research is an exemplary descriptive study in that it satisfied, to a large extent, both ecological validity and methodological rigor, as it was

carried out in classroom over an extended period of time using a pedagogically useful interactive task that systematically targeted wh-question formation.

An important prediction that skill acquisition theory makes is the skill specificity (Anderson, 1993; Dekeyser, 2015). In other words, it is postulated that the procedural knowledge gained through dedicated practice of one skill is fine-tuned to that specific skill (e.g., comprehension) and is unlikely to be used for different skills (e.g., production). According to this theory, skill transfer is possible only through declarative knowledge, which is a more general system that can be applied for different skills. The skill specificity effect has been confirmed across different types of L2 skills and linguistic domains in subsequent studies (see Li & DeKeyser, 2017; Suzuki & Sunada, 2019 for recent progress in the domain).

A new line of research from the perspective of skill acquisition theory has recently emerged, whereby the researchers started exploring the optimal conditions that are conducive for proceduralization and automatization of L2 knowledge. Optimal practice scheduling is a particularly burgeoning research area and is inspired by cognitive psychology research. L2 researchers have started to reveal the optimal timing to repeat L2 practice activities for proceduralization and automatization (see the 'Integrating perspectives' section for details).

Another key issue is the role of explicit instruction on proceduralization or automatization, which is a central topic in instructed SLA (e.g., Norris & Ortega, 2000). More recently, McManus and Marsden (2017, 2019) adopted the skill acquisition perspective to examine the role of explicit information for practicing the target L2 French grammar of *Imparfait*. In addition to explicit information about L2 target structure, they also presented explicit information about how participants' L1 (English) expresses the L2 target structure (e.g., how English expresses ongoingness and habitualness). Their findings indicated that the provision of L1 explicit information had additive benefits for accurate and faster processing (proceduralization) of target grammar.

Furthermore, researchers have started to investigate individual differences that play an important role in engaging in efficient proceduralization and automatization (Ettlinger, Bradlow, & Wong, 2014; Morgan-Short, Faretta-Stutenberg, Brill-Schuetz, Carpenter, & Wong, 2014; Pili-Moss, Brill-Schuetz, Faretta-Stutenberg, & Morgan-Short, 2019; Suzuki, 2018). Morgan-Short et al. (2014) focused on individual differences in declarative and procedural memory (part of the long-term memory system) in their laboratory research on artificial grammar learning. Their findings revealed that individual differences in declarative memory, measured by the Part V of

the Modern Language Aptitude Test (paired associate) and the continuous visual memory task (Buffington & Morgan-Short, 2019), predicted the disparities in the earlier stage of grammatical knowledge acquisition. In contrast, procedural memory, measured by the Tower of London and weather prediction tasks (Buffington & Morgan-Short, 2019), predicted the later stages of grammar knowledge. Pili-Moss et al. (2019) subsequently reanalyzed the performance data gathered during the training sessions conducted by Morgan-Short et al. (2014). They found that automatization of grammatical knowledge was predicted by procedural memory only among learners with superior declarative memory. Furthermore, Suzuki's (2018) laboratory experiment also revealed the significant role of procedural memory (measured by the Tower of London task) in automatization of novel L2 morphological structures through repeated systematic practice with the support of declarative knowledge. These findings suggest that automatization can be facilitated by higher levels of declarative and procedural memory. While these studies are well-controlled laboratory studies using an unfamiliar artificial/miniature language, Faretta-Stutenberg and Morgan-Short (2018) focused on American university students who were studying Spanish in an at-home classroom or a study-abroad context. Individual differences in procedural memory ability, as well as working memory capacity, significantly predicted the grammatical development over one semester in the study-abroad context, but not in the at-home context. Cognitive abilities are recruited differentially depending on the quality of L2 learning experiences catered by different settings, indicating the need to explore the complex interactions between cognitive mechanisms and social contexts.

Integrating Perspectives

Optimizing L2 Practice from Cognitive Psychology Perspectives

The goal of this section is to provide an overview of emerging intersections between SLA and cognitive psychology. Based on the skill acquisition perspective, several researchers have attempted to connect SLA and cognitive psychology to inform L2 education (Dekeyser, 2007; Lyster & Sato, 2013; Suzuki et al., 2019b). The central idea of this intersection is *practice.* The term *practice* is widely used in both L2 and psychology studies on skill acquisition. Here, practice is defined, from the L2 skill acquisition perspective, as "specific activities in the second language, engaged in systematically, deliberately, with the goal of developing knowledge of and skills in the second language" (Dekesyer, 2007, p. 1). This broader conceptualization departs from the narrower, more traditional Audiolingual idea of practice (e.g., decontextualized drill and exercises) and embraces both form-focused and meaning-focused activities where

learners engage in systematic and deliberate use of L2 knowledge. Meaning-focused practice, for instance, involves extensive reading and listening, interactive information−gap activities, discussion tasks, etc. More importantly, form-focused activities that are widely used in foreign language context, such as oral reading and shadowing (Kadota, 2019), but are often treated as marginal in some approaches (e.g., task-based language teaching) can be included as practice activities.

Findings yielded by empirical L2 research informed by cognitive psychology shed light on the ways practice can be optimized. In what follows, three key sub-areas of L2 practice that are closely tied to psychology of learning are highlighted to provide implications for L2 teaching and learning.

Retrieval Practice and Overlearning: Maximizing Deliberate Vocabulary Learning

Cognitive psychology research (e.g., Karpicke & Roediger, 2008) has shown that *testing* facilitates learning and retention. In this context, testing is not limited to paper-and-pencil assessments, but rather relates to *retrieval*, referring to the general process of accessing previously stored information. Cognitive psychologists found the benefits of retrieval practice for learning a variety of materials, such as word lists, paired associates, passages, and trivia facts (Chan, Meissner, & Davis, 2018).

Barcroft (2007) examined the effects of retrieval opportunities for deliberate vocabulary learning by English native speakers of L2 Spanish. As shown in Figure 2, in the retrieval condition, participants saw both target word and picture for six seconds (e.g., *serrate* and a picture of "saw") and then saw the picture only (e.g., the picture of saw) for another six seconds, which provided an opportunity for retrieving the word form (e.g., *serrate*). In the non-retrieval condition, participants saw both the word and the corresponding picture for 12 seconds. The advantage of retrieval practice was demonstrated in the immediate posttest and it was found to persist for up to seven days.
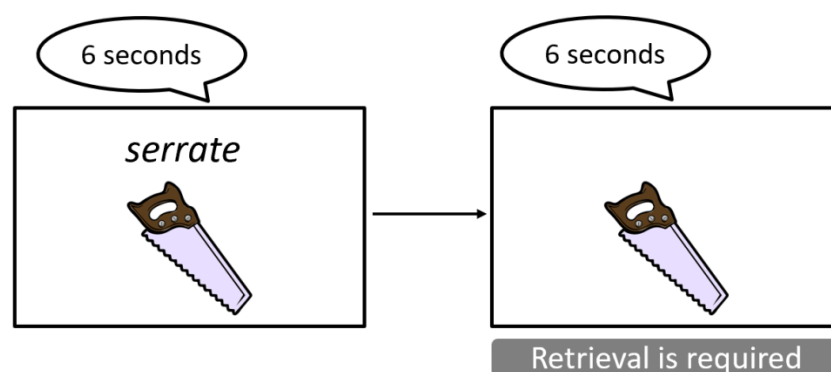

Figure 2. An illustration of retrieval practice in Barcroft (2007)

Van Den Broek, Takashima, Segers, and Verhoeven (2018) extended the research on the retrieval practice effect to the contextualized L2 vocabulary learning. Participants in their study were exposed to novel words (e.g., *fungo*) through reading either an uninformative text (e.g., "I need the *funguo*.") which necessitated retrieval of the word meaning from memory, or an informative text ("I want to unlock the door: I need the *funguo*.") where word meaning was inferable and retrieval was not required. The results achieved by these two conditions on the 7-day delayed posttest showed that retrieval practice using the uninformative texts led to more correct recalls.

Furthermore, Nakata (2017) examined an interesting question regarding frequency of retrieval practice. In his study, both *effectiveness* (posttest score) and *efficiency* (posttest score divided by study time) of deliberate vocabulary learning were examined. The Japanese university students studied unfamiliar English words using a retrieval technique in a single session, while the frequency of retrieval practice was varied from one, three, five, to seven. The author found that, the higher retrieval practice frequency, the greater the number of words recalled correctly on both immediate and delayed posttests. However, in terms of efficiency, the single retrieval practice opportunity was found to be the most optimal. These findings suggest that, when learners want to make most of their time, they do not have to repeat retrieval practice within the single study session, but should rather distribute it across multiple study sessions (Rohrer, Taylor, Pashler, Wixted, & Cepeda, 2005).

These results corroborate the findings in psychology on *overlearning* (Rohrer et al., 2005). Overlearning refers to the continued practice beyond one successful performance of certain task. It is the means of ensuring long-term retention most commonly recommended in textbooks about education and training. Although a meta-analysis (Driskell, Willis, & Copper, 1992) suggests the medium-effect benefit of overlearning in the short term (one week or less), overlearning may not necessarily be effective, particularly for long-term retention (Rohrer et al., 2005). As Nakata (2017) pointed out, most word learning seems to occur during the first retrieval practice. Thus, it is unlikely that practicing retrieval multiple times within the same study session would be justified by its cost (i.e., spending more study time within the same session).

Research on overlearning has important implications for L2 teachers and learners, as it informs their decision on how much L2 learners should practice their skill to maximize the effectiveness and efficiency of skill and knowledge retention. Yet, extant research on this topic in both psychology and L2 research is limited in scope

focusing primarily on vocabulary learning (cf. Lambert, Kormos, & Minn, 2017; Suzuki & Hanzawa, 2021 for speaking practice).

Distributed Practice: Best Timing of Repeated Practice

As previously pointed out, overlearning may not be effective for long-term retention. Instead, in cognitive psychology research, distributing practice opportunities over multiple study sessions has been proven more valuable for long-term retention (e.g., Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006). Therefore, identifying optimal study schedules that can enhance L2 learning is an important issue. It is no wonder that this topic has recently attracted extensive attention by L2 researchers. Distributed practice effects have been examined in both laboratory and classroom settings in studies focusing on different linguistic domains: vocabulary (Kanayama & Kasahara, 2017; Nakata, 2015; Nakata & Suzuki, 2019a; Rogers & Cheung, 2018; Schuetze, 2015; Serrano & Huang, 2018), pronunciation (Li & Dekeyser, 2019), and grammar (Bird, 2010; Kasprowicz, Marsden, & Sephton, 2019; Rogers, 2015; Suzuki, 2017; Suzuki & Dekeyser, 2017a).

In a most comprehensive study in the field of psychology, Cepeda, Vul, Rohrer, Wixted, and Pashler (2008) demonstrated that the optimal spacing is determined by the ratio of inter-session interval (ISI) and retention interval (RI) (see Figure 3).
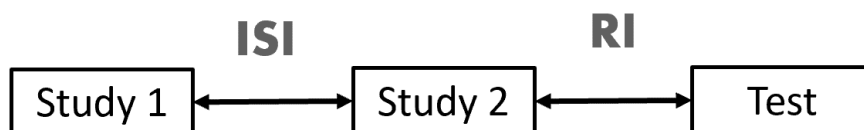
Recall			Recognition		
RI (days)	Optimal ISI (days)	ISI/RI Ratio	RI (days)	Optimal ISI (days)	ISI/RI Ratio
7	3	43%	7	1.6	23%
35	8	23%	35	7	20%
70	12	17%	70	10	14%
350	27	8%	350	25	7%

Figure 3. Optimal intersession interval (ISI) to retention interval (RI) ratio found in Cepeda et al. (2008)

Participants in this study remembered trivial facts (e.g., What European nation consumes the most spicy Mexican food? "Norwegians") under different relearning schedules. The findings reported by Cepeda et al. (2008) indicate that the longer the RI, the longer the optimal ISI. The optimal ratios for memory recall and recognition were similar except for the 7-day RI (see Figure 3).

L2 researchers have explored the extent to which findings reported by Cepeda et al. (2008) are applicable to L2 learning. In L2 grammar learning, which is the most debated and examined linguistic domain, some empirical experiments (Bird, 2010; Rogers, 2015) indicate that the optimal ISI-RI ratio is consistent with that obtained by Cepeda et al. (2008). However, experiments conducted by other authors (Kasprowicz et al., 2019; Suzuki, 2017; Suzuki & Dekeyser, 2017a) suggest that the optimal ISI-RI relationship is different for L2 grammar learning.

The discrepancy in the findings may be attributed to several moderating factors, such as complexity of target skills (Donovan & Radosevich, 1999), experimental context, such as laboratory versus classroom (Rogers & Cheung, 2018), frequency of study sessions and posttests (Suzuki, 2017), skill/knowledge type, such as declarative and procedural (Li & Dekeyser, 2019; Suzuki & Dekeyser, 2017a), and individual differences in learners' aptitudes, such as working memory and language analytic ability (Kasprowicz et al., 2019; Suzuki, 2019; Suzuki & Dekeyser, 2017b). Further investigations in both laboratory and classroom contexts are thus needed to obtain a more nuanced picture of distributed practice effects from theoretical and pedagogical points of view.

Interleaved Practice: Optimizing Exemplar Presentation Order

Another issue related to the practice schedule is whether to use blocked or interleaved schedules. Interleaved practice refers to a teaching technique where multiple exemplars from different categories are presented in a mix (e.g., ABCDCADBACBD), whereas blocked practice involves a sequence of exemplars blocked by category (e.g., AAABBBCCCDDD). Cognitive psychology research shows that interleaving results in better retention than blocking (Kang, 2016; Taylor & Rohrer, 2010).

Based on their recent meta-analysis of studies on interleaving effects, however, Brunmair and Richter (2019) suggested that the effectiveness of blocking and interleaving depends on features of the learning materials. For instance, blocking does indeed seem more effective than interleaving for learning unfamiliar pronunciations that widely differ across categories (Carpenter & Mueller, 2013). In their study on pronunciation learning, Carpenter and Mueller (2013) asked participants to read French

words for which lexico-phonological rules were very different (e.g., *ba<u>eau</u>*, *vernis*, *brum<u>eux</u>*). Blocked presentation of exemplars from the same category (e.g., *bat<u>eau</u>*, *carr<u>eau</u>*, *corb<u>eau</u>*, *fard<u>eau</u>*) seemed to have facilitated noticing the common features (e.g., *eau*) among the exemplars presented in a row.

On the other hand, findings yielded by recent research indicate that interleaved practice is beneficial for L2 grammar learning (Nakata & Suzuki, 2019b; Pan, Tajrana, Lovelett, Osuna, & Rickard, 2019; Suzuki & Sunada, 2019; Suzuki, Yokosawa, & Aline, in press). Figure 4 illustrates sample sequences of 24 practice items on relative clauses under blocked and interleaved schedules (Suzuki & Sunada, 2019). In the blocked schedule, exemplars of subjective relative clauses (SR) *who* are presented, followed by a block of SR *which* exemplars, object relative clause (OR) *whom*, and OR *which*. In contrast, in the interleaved practice schedule, these exemplars of four syntactic categories are randomized.

Blocked Schedule

SR-who	SR-who	SR-who	SR-who	SR-who	SR-who	SR-which	SR-which	SR-which	SR-which	SR-which	SR-which
OR-whom	OR-whom	OR-whom	OR-whom	OR-whom	OR-whom	OR-which	OR-which	OR-which	OR-which	OR-which	OR-which

Interleaved Schedule

SR-who	SR-which	OR-whom	OR-which	OR-whom	SR-which	SR-who	OR-which	SR-which	SR-who	OR-which	OR-whom
SR-which	OR-whom	OR-which	SR-who	SR-which	OR-which	SR-who	OR-whom	SR-who	OR-whom	SR-which	OR-which

Hybrid Schedule

SR-who	SR-who	SR-who	SR-which	SR-which	SR-which	OR-whom	OR-whom	OR-whom	OR-which	OR-which	OR-which
SR-which	OR-whom	OR-which	SR-who	SR-which	OR-which	SR-who	OR-whom	SR-who	OR-whom	SR-which	OR-which

Sample Sentences

- SR-who: That is the boy who is kissing the dog.

- SR-which: That is the kangaroo which is massaging the boy.

- OR-whom: That is the man whom the woman is pushing.

- OR-which: That is the bird which the cat is watching.

Figure 4. Blocked, interleaved and hybrid, practice of relative clauses from Suzuki and Sunada　(2019)

The categories of these target linguistic features (e.g., SR *which* and OR *which*) are similar to each other, and interleaved practice can facilitate the discrimination of those similar features by highlighting subtle differences (Kang & Pashler, 2012). The advantage of interleaving was found in the acquisition of English tense-aspect-mood distinction (Nakata & Suzuki, 2019) and Spanish past-tense morphology (Pan et al., 2019), as well as in English relative clause/adverb construction (Suzuki & Sunada, 2019; Suzuki et al., under review).

Furthermore, Suzuki and colleagues (Nakata & Suzuki, 2019b; Suzuki & Sunada, 2019) recently explored the effectiveness of hybrid (increasing) practice, whereby blocked and interleaved practice were combined, as shown in Figure 4. Theoretically, when hybrid practice schedule is adopted, the difficulty of practice can be increased gradually from blocking to interleaving in order to optimally challenge learners for better retention of knowledge and skills—desirable difficulty (Schmidt & Bjork, 1992; Suzuki, Nakata, & Dekeyser, 2019a; see also Figure 5). The empirical findings related to the effectiveness of this method are presently limited as well as mixed. While Nakata and Suzuki (2019) failed to establish the advantage of hybrid practice, Suzuki and Sunada (2019) found it superior to blocked or interleaved practice alone. As in the case of distributed practice, there are several key moderating factors that need to be taken into account for optimizing the sequence of exemplars (Fuhrmeister & Myers, 2020; Suzuki et al., in press).

Implications for Practice and Research

The L2 teaching and learning techniques introduced in this section have obvious pedagogical implications for enhancing learning from SLA and cognitive psychology perspectives. Implications of many of the findings are somewhat straightforward (e.g., incorporating more retrieval practice). Interestingly, however, many teachers and students are unaware of the benefits of retrieval, distributed, and interleaved practice

(Karpicke, 2009; Karpicke, Butler, & Roediger III, 2009; Nakata & Suzuki, 2019b). This means that L2 learners and teachers need to become aware of and take advantage of these effective techniques for learning. One way to achieve this is to provide strategy-based instruction for promoting the use of effective techniques. Another approach may be to create materials and computerized programs that automatically optimize the practice formats and learning schedules using portable devices such as smartphones (e.g., Lin & Lin, 2019).

In order to advance a research agenda for a more systematic investigation of L2 practice, Suzuki et al. (2019b) proposed an overarching framework for L2 practice shown in Figure 5. This framework stipulates that three factors—(a) practice condition, (b) linguistic difficulty, and (c) learner-related difficulty—determine the overall difficulty levels of L2 practice. It is, therefore, useful for researchers aiming to establish the optimal values of multiple variables for achieving the levels of difficulty that would yield the best learning outcomes (Schmidt & Bjork, 1992).
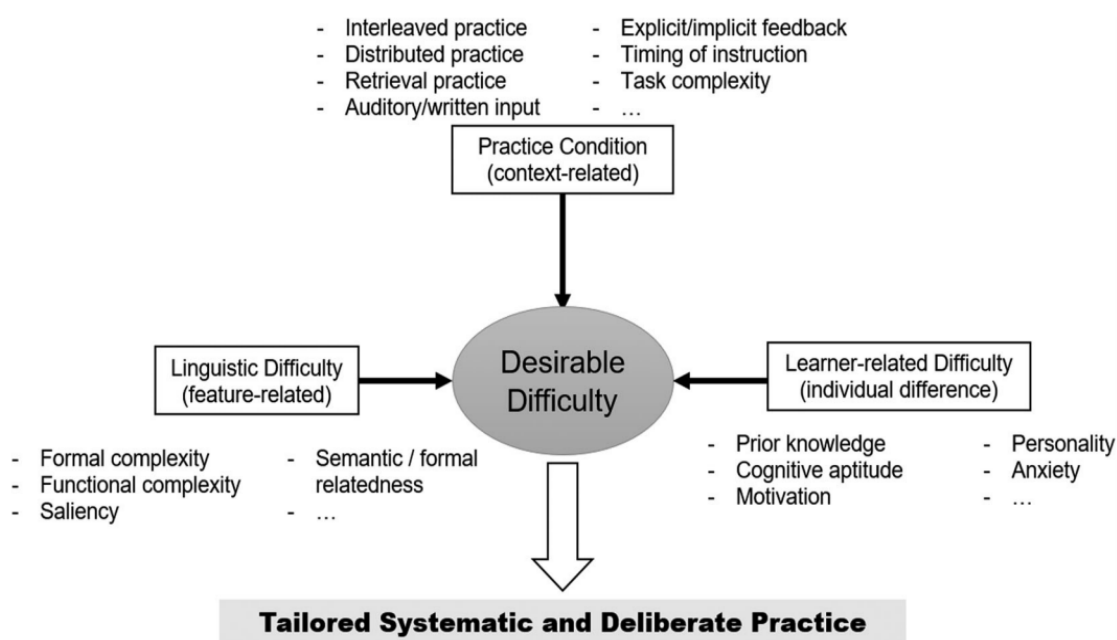

Figure 5. An overarching theoretical framework for systematic and deliberate L2 practice. From Suzuki, Nakata, and DeKeyser (2019a).

For instance, Nakata and Suzuki (2019a) examined whether the effectiveness of massed and spaced vocabulary learning (practice condition) was moderated by semantic relatedness of vocabulary (linguistic feature). Studying semantically-related words (e.g., baboon, badger, otter, raccoon) induces interference effect (i.e., genearting an incorrect

lexical item in the same semantic category such as confusing "baboon" with "otter"), which presumably increases learning difficulty and creates a optimally challenging learning condition. Nakata and Suzuki (2019a) found that spaced learning reduced the semantic interference of studying semantically-related words, which resulted in the less knowledge retention compared to semantically-unrelated words. This suggests that the effectiveness of practice condition should be evaluated by taking into account relevant aspects of linguistic difficulty (e.g., semantic relatedness).

Furthermore, the effectiveness of distributed practice is also influenced by a set of cognitive aptitudes such as working memory and language analytic ability (Kasprowicz et al., 2019; Suzuki, 2019; Suzuki & Dekeyser, 2017b). Compared to cognitive factors like aptitude, however, relatively little attention has been given to the affective and motivational factors for research on L2 practice. Given that practice should be done repeatedly and extensively for developing knowledge and skills, motivation and engagement are important moderating factors of the amount and potentially effectiveness of practice (de Bruin, Kok, Leppink, & Camp, 2014; see Chapters 10 and 11). It is thus important to investigate how learners' intrinsic motivation such as interest, enjoyment, and satisfaction (e.g., McEown & Oga-Bladwin, 2019) can be engaged and sustained during practice over an extended period of time.

This overarching framework of L2 can capture the complexity of cognitive, affective and conative factors involved in L2 practice in a variety of social settings. As there is no single best method of practice for all learners, the framework will provide a foundation for understanding how the key factors can be modulated to create optimal practice conditions for learning a particular linguistic feature for a group of learners with particular characteristics in a given setting (see Suzuki, Nakata, & DeKeyser, 2020 in more detail). In sum, the implications of these findings stemming from cognitive psychology and L2 research are not only informative for teachers, learners, and material developers, but also for researchers who can find stimulating synergies between cognitive psychology and L2 research.

Future Directions

In this chapter, an overview of cognitive underpinnings and research findings of L2 learning was provided from the perspective of one cognitive L2 theory—skill acquisition theory. In cognitive approaches, memory and knowledge are treated as the key systems underlying learning. Research guided by skill acquisition theory has thus largely focused on declarative−procedural−automatized L2 knowledge. Due to the need to impose methodological control over the experimental treatment in empirical research,

attention is typically given to a single target linguistic point while participants are subjected to decontextualized practice using single sentences. This limitation is critical when attempting to elucidate the pedagogical implications of the findings yielded for teaching, because such highly controlled study protocols have little resemblance to actual L2 use for communication.

In order to overcome this limitation, an emerging line of investigations aims to broaden the scope of research by integrating the idea of distributed/interleaved practice to a task-based language teaching (TBLT) perspective (e.g., Ellis, Skehan, Li, Shintani, & Lambert, 2020). For instance, Bui, Ahmadian, and Hunter (2019) examined the distributed practice effects of task repetition practice in which EFL learners engaged in oral picture description task twice. Their findings indicated that different amounts of spacing (0-day, 1-day, 3-day, 7-day, and 14-day ISIs) influence complexity−accuracy−fluency (CAF) performance in speaking tasks. Similar efforts were made by Suzuki (2021), who examined fluency development in speaking skills and compared blocked practice and interleaved practice. In this study, EFL learners engaged in six-frame cartoon narrative task nine times over three study sessions under either blocked (Day 1: Cartoon AAA, Day 2: Cartoon BBB, Day 3: Cartoon CCC) or interleaved condition (Day 1: ABC, Day 2: ABC, Day 3: ABC). Their posttest performance indicated that the blocked practice led to significant gains in some aspects of utterance fluency (e.g., faster articulation rate). In addition to the investigation into the acquisition of a specific linguistic structure, the effects of repeated practice need to be examined from a more global perspective including CAF analysis as in Bui et al. (2019) and Suzuki (under review) and, ideally, in conjunction with other affective and motivational factors that are discussed in this handbook.

This line of research is promising for both theoretical and pedagogical reasons. Theoretically, these attempts are considered transdisciplinary, as cognitive psychology findings are tested in the context of TBLT (e.g., Ellis et al., 2020). Pedagogically, the findings will be particularly useful in formulating task sequencing guidelines for teachers for maximizing students' L2 skill development. In order to make these findings substantial and reliable for L2 education stakeholders (e.g., teachers, learners, and policy makers), researchers continue to seek the generalizability of empirical findings in both classroom-based and laboratory-based longitudinal studies.

In this chapter, the strengths of a cognitive approach in psychology and L2 research were highlighted—strong theoretical and psychological foundations in memory and knowledge that serve as the basis for effective teaching and learning. From an L2 acquisition perspective, skill acquisition theory was presented to postulate that learning

process occurs in three stages, i.e., it follows the declarative−procedural−automatization sequence. Furthermore, an emerging interdisciplinary research area linking SLA and cognitive psychology was highlighted and situated in the broader conceptualization of L2 practice. The focused review of three main research streams—retrieval practice, distributed practice, and interleaved practice—were presented, and these pedagogical techniques on L2 learning are highly relevant for L2 classroom and useful for maximizing the effectiveness of L2 practice. Finally, an overarching theoretical framework of L2 practice for creating desirable difficulty and optimizing L2 learning was presented which can inform not only research, but also L2 curriculum and material development, as well as digital learning.

Reflection Questions

1. What aspect of L2 learning can skill acquisition theory explain most directly?
2. How do other perspectives and constructs described in this handbook resonate with the cognitive view of L2 learning (e.g., declarative−explicit and procedural−implicit knowledge, desirable difficulty)?
3. How can L2 teachers incorporate cognitive psychology/L2 research findings on retrieval, distributed, and interleaved practice into their classroom practices?

Recommended Reading

DeKeyser, R. M. (2015). Skill acquisition theory. In B. VanPatten & J. Williams (Eds.), *Theories in second language acquisition: An introduction* (2nd ed., pp. 94−112). New York, NY: Routledge.

This book chapter provides an authoritative account of skill acquisition theory in L2 learning. It also explains how skill acquisition theory contributes to the explicit−implicit debate.

Suzuki, Y., Nakata, T., & DeKeyser, R. M. (2019b). Optimizing second language practice in the classroom: Perspectives from cognitive psychology. *The Modern Language Journal*, *103*, 551−561. doi:10.1111/modl.12582

The special issue of *The Modern Language Journal* showcases empirical studies that approach L2 practice from a perspective of cognitive psychology. This introductory paper gives an overview of the state-of-the-art empirical research on various practice-related topics, such as retrieval practice, distributed practice, interleaved practice, integrated practice, and individual differences.

Horvath, J. C., Lodge, J. M., & Hattie, J. (2016). *From the laboratory to the classroom: Translating science of learning for teachers*. New York, NY: Routledge.

This edited book provides a comprehensive overview of research in the field of science of learning. As the title indicates, its aim is to build a bridge between laboratory research findings and real classroom practice in various cognitive and other aspects of learning.

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